CONCEPTUAL PLAN FOR THE MANAGEMENT AND MONITORING OF TWO OCEAN DISPOSAL SITES OFF GRAYS HARBOR, WASHINGTON

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EXECUTIVE SUMMARY

As part of the Grays Harbor Navigation Improvement Project, an estimated 11.4 million yd^3 of materials dredged from Grays Harbor are destined for open water disposal at two estuarine and two ocean disposal sites. After an extensive series of studies, the Seattle District of the U.S. Army Corps of Engineers selected two ocean disposal sites, the Southwest Site and the 8-Mile Site, which are the subject of this report. Disposal operations at these ocean sites are to be managed so that any significant adverse impacts on resources, resource use, or other amenities are contained within the sites and do not migrate beyond their boundaries. This report describes the two ocean disposal sites, outlines the disposal operations, and presents a conceptual plan for monitoring and managing the sites.

The Southwest Site in the SW Navigation Lane is shaped like a parallelogram, has an area of 1.7 stat mi^2 and will receive sandy materials dredged from the Grays Harbor Bar. The 8-Mile Site is circular. has an area of 0.5 stat mi^2 and is to receive silty material dredged from the upper reaches of Grays Harbor. Of the total construction material, 4.5 million yd^3 is destined for disposal at the two ocean sites: 2.3 million yd^3 to the Southwest Site and 2.3 million yd^3 to the 8-Mile Site. After construction, the annual rate at which Southwest Site will receive bar sand will decrease from an estimated 800 thousand yd^3 per year in the first year to 500 thousand yd^3 per year in the fifth and following years. After construction, no disposal of dredged material will occur at the 8-Mile Site.

Compliance monitoring is the management activity designed to verify that the dredged materials are being dumped in the correct location at the correct time. In the Grays Harbor Project, dredge logs, coupled with periodic dredge inspection by agency personnel, will be used to verify that materials dredged from specific reaches are transported and dumped at the appropriate site. Monitoring the dumping position can be accomplished with a Miniranger positioning system with track plotter and load meter.

The general objective of the monitoring plans for the 8-Mile and Southwest Sites are, first, to verify that no harm to resources, resource use, or the ecosystem occurs beyond the site boundaries and, second, to provide specific information to support informed decisions about management of the sites and the disposal operations. The site monitoring activities are intended to detect whether significant adverse environmental impacts are occurring on resources or resource use beyond the site. Monitoring information is gathered and then considered to determine whether some sort of corrective or remedial action is necessary.

For both sites, a tiered approach to monitoring will be employed. Two tiers per site are proposed. The first tier at the 8-Mile Site entails bathymetric surveys. surveys with side-scan sonar and a subbottom profiler. and sediment sampling to assess changes in the size and shape of the mound and to seek evidence of sediment transport. A decision rule in the form of a testable hypothesis will be used to determine whether to undertake Tier 2 activities. If implemented, Tier 2 at the 8-Mile Site would be more sediment sampling to investigate sediment transport. The 8-Mile Site receives material only during construction, and because no remedial action is possible, the data from any Tier 2 activities at that site would be used to understand how the behavior of the disposal mound differed from that expected.

At the Southwest Site, Tier 1 activities also entail bathymetric surveys to assess changes in the size and shape of the disposal mound, and TV tows and trawls to verify that the crab distribution is that expected. A decision rule formulated as a testable hypothesis about crab distribution will be used to assess the need for Tier 2 activities. Tier 2 would primarily be a trawl survey to evaluate the significance of any observed departures from the expected crab distribution. An assessment activity occurs at each stage of monitoring to determine the need for any changes in monitoring or disposal operations.

Monitoring is scheduled for the 2 years of construction and for 2 years postconstruction. A synthesis of the monitoring prepared 2 years after construction will assess the need for further monitoring.

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During disposal operations, these sites are to be managed so that any significant adverse impacts on resources, resource use, or other amenities are contained within the site and do not migrate beyond its boundaries. The foundation of effective site management is the appropriate selection and location of the site. After numerous studies had addressed concerns about impacts on resources and resource use (see the Ocean Surveys Report of Pearson et al. 1987 for an overview of many of these studies), two sites out of seven potential ones were selected and their locations established to eliminate potential impacts on resources or resource use around the sites. In developing the site management plan, potential impacts are considered and addressed and contingency plans created to manage potential adverse impacts.

In 1986, the Seattle District of the COE requested the Battelle/Marine Research Laboratory of the Pacific Northwest Laboratory to develop a conceptual plan for the management and monitoring of the two ocean disposal sites off Grays Harbor. The objectives of this conceptual plan are the following:

- To describe the two selected sites
- To discuss the dredged materials and disposal operations planned for each site
- To present the activities proposed for monitoring the sites
- To discuss the process for making decisions concerning any need for changes in the disposal operations.

A major concern in site selection was locating the sites to avoid high concentrations of Dungeness crab, <u>Cancer magister</u>. During the Ocean Surveys (Pearson et al. 1987), no adult and few juvenile Dungeness crab were observed within the 8-Mile Site. During the Spring 1985 Survey, a large concentration of newly settled young-of-the-year (YOY) crab was observed north of the SW Navigation Lane between the 100- and 120-ft contours. The shape and location of the Southwest Site have been designed to avoid disposal in this area of high crab concentration. For the Southwest Site, this plan describes disposal operations timed to avoid the high crab concentrations during their seasonal occurrence.

DESCRIPTION OF THE OCEAN DISPOSAL SITES

The principal physical, chemical, and biological features of the two sites are summarized in Table 1, and detailed descriptions of the features within and around the sites and tabulations of data about the sites appear in the Ocean Surveys Report (Pearson et al. 1987). Descriptions of the size. shape. and location of the sites are given here. Figure 1 indicates their location in relation to Grays Harbor.

THE 8-MILE SITE

The 8-Mile Site (see Figure 1) is contained within a portion of a relict gravel deposit about 8 statute miles (7.1 n mi) west-northwest of the entrance to Grays Harbor. The site is circular with a radius of 0.40 stat mi and an area of 0.5 stat mi^2. The center of the site is located at 124° 20.6'W and 46° 57.0'N. Across the site, depth increases gradually from 140 to 160 ft (Table 1).

The hydrographic features appear typical of the general coastal region and include a stratified water column and bottom water of low dissolved oxygen (DO) from late spring through early fall. The relict deposit is surrounded by sandy bottom, but the site is entirely contained within the deposit's one bottom type, which is composed primarily of gravel (42%-87%) with coarse sand (12%-53%). The conspicuous waveforms that run north and south within the deposit pass through the site.

The biological features of the 8-Mile Site appear unremarkable (Table 1; Pearson et al. 1987). The infaunal community is dominated by the polychaetes, *Mediomastus* spp., and has low biomass, abundance, and taxa richness. No razor clams were detected within the site. The average total catch weight of the macroepifauna was low, and Dungeness crab were a minor component. Within the site, no adult Dungeness crab were observed and juvenile crab had a low average density. Sand lance *Ammodytes hexapterus* occurred primarily around the site, and the TV tows and trawls did not confirm an earlier impression that the gravelly bottom of the 8-Mile Site might have high value as a resource for sand lance.

TABLE 1. The Principal Features of the Two Candidate Ocean Disposal Sites off Grays Harbor, the 8-Mile Site and the Southwest Site. Data is taken from Pearson et al. (1987).

Feature	8-Mile Site	Southwest Site	
Depth (ft)	140 to 160	90 to 120	120 to 140+
Bottom type	Gravel	Sand	Sand
Grain Size	Gravel with coarse sand	Very fine sand with 10% silt and clay	Very fine sand with 10% silt and clay
TOC (%)	0.13	0.33	0.28
Water content (%)	28.3	37.10	38.4
Bottom water			
Temperature (°C)	7 to 8	7 to 11	7 to 8
Salinity (°/oo)	31 to 36	33 to 35	31 to 35
DO (mg/L)	1 to 7	2 to 8	2 to 8
Near-bottom turbidity layer	None	Moderate	Low to Moderate
Bottom water type	Subsurface Oceanic Water	Subsurface Oceanic Water	Subsurface Oceanic Water
Stratification	Spring to fall	Spring to fall	Spring to fall
Infauna			
Dominant	*Mediomastus* spp.	*Owenia fusiformis*	*Owenia fusiformis*
Biomass (g/0.115 m^2)	0.1774	1.4613	1.5335
Numbers (ind./0.115 m^2)	112	8498	9583
Taxa richness (taxa/0.115 m^2)	11	22.6	28.7
Razor clams (clam/m^2)			
Siliqua sloati	0	258	24
Siliqua ? patula	0	4	0

Feature	8-Mile Site		Southwest Site
Epifauna			
Dominant	Round and faltfish	Crab	Crab
Mean catch weight (kg/ha)	2.2	2.3	29.4
Sand lance	Highest densities outside site	None observed	Only one observation
Dungeness crab density			
Large (crab/ha)	None observed	9	12
Juvenile (crab/ha)	Low	Seasonally variable	Seasonally variable
All surveys	237	4942	2017
Fall 1984	467	1385	1281
Spring 1985	62	6106	3509
Fall 1985	42	28	1117

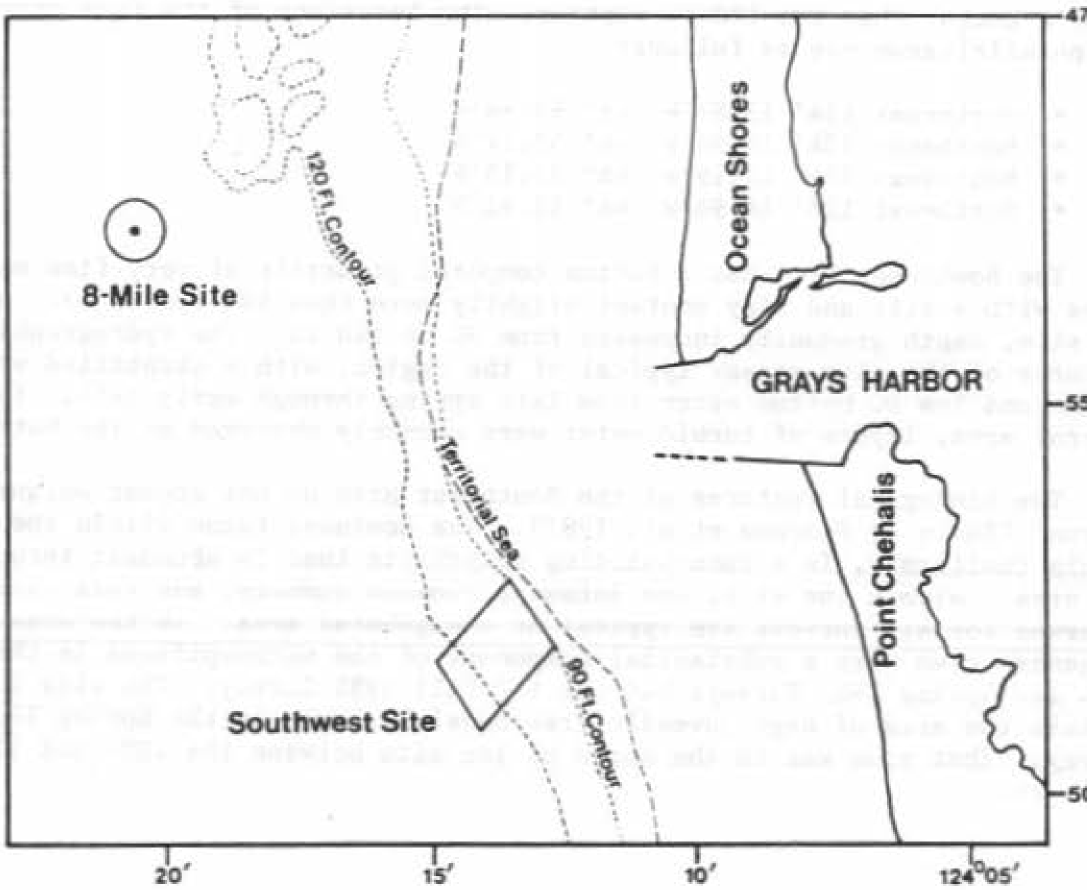

FIGURE 1. The Two Sites for Ocean Disposal of Dredged Materials from Grays Harbor

THE SOUTHWEST SITE

The Southwest Site (see Figure 1) is located within the SW Navigation Lane leading to the Grays Harbor Entrance and is outside the Territorial Sea (the 3-Mile Limit). The site is shaped like a parallelogram and has an area of 1.66 stat mi^2 (1.25 n mi). The short sides of the parallelogram are approximately 6000 ft long; the long sides, 8000 ft. The shoreward edge of the site lies along the 90-ft depth contour. Approximately one-third of the site is deeper than the 120-ft contour. The locations of the four corners of the parallelogram are as follows:

- Northeast 124° 13.81'W 46° 52.94'N
- Southeast 124° 12.96'W 46° 52.17'N
- Southwest 124° 14.19'W 46° 51.15'N
- Northwest 124° 14.96'W 46° 51.92'N

The Southwest Site has a bottom composed primarily of very fine marine sands with a silt and clay content slightly more than 10% (Table 1). Across the site, depth gradually increases from 90 to 140 ft. The hydrographic features of the site appear typical of the region, with a stratified water column and low DO bottom water from late spring through early fall. In the general area, layers of turbid water were commonly observed at the bottom.

The biological features of the Southwest Site do not appear unique or unusual (Table 1; Pearson et al. 1987). The dominant taxon within the site, Owenia fusiformis, is a tube-building polychaete that is abundant throughout the area. Within the site, the infaunal biomass numbers, and taxa richness observed for all surveys are typical of the general area. In the area, Dungeness crab were a substantial component of the macroepifauna in the Fall 1984 and Spring 1985 Surveys but not the Fall 1985 Survey. The site does not contain the area of high juvenile crab densities seen in the Spring 1985 Survey. That area was to the north of the site between the 100- and 120-ft contours.

MATERIALS FOR DISPOSAL

The Interim Feasibility Report (U.S. Army Corps of Engineers 1982) gave 17.2 million yd^3 as the total amount of material to be dredged during construction for the Grays Harbor Project. Because of changes in project design, the total amount of construction material is now expected to be 11.4 million yd^3 (Dr. J. O. Waller, Seattle District, COE, personal communication). Of that total construction material, 4.5 million yd^3 is destined for ocean disposal: 2.3 million yd^3 to the Southwest Site and 2.3 million yd^3 to the 8-Mile Site.

The 8-Mile site will receive material only during construction and no material will be deposited at this site after completion of construction. Material destined for this site will be sandy silt from three upper reaches in Grays Harbor. All this material will be dredged by clam-shell dredges and transported to the site by scow. The specific reaches, amounts of material, time to dredge, and time windows will be the following:

Reach	Amount (1.000 yds)	Time (months)	Window	Year
Hoquiam	1065	3.2	1 May - 31 July	Year 1
Cow Point	371	1.6	16 June - 31 July	Year 1
Aberdeen	913	3.2	1 May - 31 July	Year 2
	2349	8.0		

The Southwest Site will receive material during both construction and maintenance. Material destined for this site will be sand from the Grays Harbor Bar. All this material will be dredged and transported by hopper dredges. During construction, 2.3 million yd^3 of material will be dredged in 4 months between June and September of Year 1. During each year of maintenance, material will be dredged from the bar over approximately 1 month between June and September. In the first year after construction, the Southwest Site will receive an estimated 800 thousand yds of bar sand. Over the next few years of maintenance, the amount of material destined for the Southwest Site will decrease to and then remain at 500 thousand yd^3 per year in the fifth and following years. Over the 50-year life of the project, the Southwest Site is expected to receive a total of 28.0 million yd^3 of sandy material from the Grays Harbor Bar.

Appendix A of the Interim Feasibility Report (U.S. Army Corps of Engineers 1982) provides data on the chemical and physical characteristics of the material to be dredged in the Grays Harbor Project. The sand from the Grays Harbor Bar is clean, so there is no concern for any toxic effects from contaminants. The sandy silt from the upper reaches has been subjected to chemical analyses, elutriate bioassays, and bioaccumulation studies to determine its fitness for aquatic disposal (AM Test 1981, Pierson et al. 1983, Brown et al. 1984). In the Interim Feasibility Report (U.S. Army Corps of Engineers 1982), the dredged materials at all but one location were judged acceptable for open-water disposal. At one station there was significant bioaccumulation of phthalate esters, and under the recommended plan, this material was destined for confined disposal while the remaining material was judged acceptable for open-water disposal. Further sampling of sediments and biota in Grays Harbor found low concentrations of phthalates in sediments, and, with few exceptions, phthalates were not detected in clams and amphipods from Grays Harbor and then not in concentrations above those found in unurbanized locations elsewhere (Brown et al. 1984). On the basis of studies since the Interim Feasibility Report (U.S. Army Corps of Engineers 1982), all the material from Grays Harbor has now been judged acceptable for open-water disposal (Letter of Decision from Washington State Department of Ecology to the Seattle District of the Corps of Engineers, June 10, 1987).

DISPOSAL OPERATIONS

THE 8-MILE SITE

Sandy silt dredged by clam shell from the upper reaches of Grays Harbor will be transported by scow for disposal at the 8-Mile Site. The dump location will be indicated by Miniranger or Loran-C coordinates provided to the towboat operators by the COE. Two or three scows will be used per transport cycle. The capacities of individual scows vary from 1500 to 4000 yd^3. Considerable experience at other ocean disposal sites (Morton 1983, Bokuniewicz and Gordon 1980, Sustar et al. 1976) indicates that cohesive silty material dredged by clam shell will go to the bottom in clumps and form a cloddy mound. Experience at a deep water (295 ft) site indicates that in water depths over twice that considered here, non-cohesive silty material can form a low profile, pancake-shaped mound (Bajek et al. 1987).

THE SOUTHWEST SITE

Disposal operations at the Southwest Site are designed to address two concerns: avoidance of excessive height of the disposal mound and avoidance of disposal between the 100- to 120-ft contours during the time when newly settled juvenile crab may be present. The sandy material destined for the Southwest Site will be dredged by hopper dredges and is expected to act like sandy materials dumped at other sites. Unlike cohesive sediments that fall as clumps and can build cloddy mounds directly under the dumping position, sandy sediments fall as discrete particles (Sustar et al. 1976) and tend to form low profile mounds that spread from the dump position, becoming thinner as they spread. In individual dumps off San Francisco, California, maximum deposition directly beneath the hopper was 2 inches and deposition approached zero at 400 ft perpendicular to the centerline of the hopper dredge (Sustar et al. 1976). The water content of the material largely determines the degree of spreading and height of the mound (Bowen 1976).

Concern for excessive height of the disposal mound arises from recent experience in Oregon. At the Yaquina Bay ocean disposal site off Newport, Oregon, continual disposal of bar material has resulted in the elevation of the disposal mound to a point where there is concern for navigation. Over 2 years, precise dumping at the same position resulted in a 23(±3)-ft-highmound that reportedly was causing focusing of wave energy and steep wave conditions on the Yaquina Bar (Reese and Turner 1986). To avoid a similar occurrence at the Southwest Site, the dumping positions may have to be systematically rotated through the site. Over the life of the project, the Southwest Site will receive 28 million yd^3 of sandy material which if evenly spread over the 1.66-mi^2 site would produce a mound approximately 27 ft high. The shallowest depth in the site is 90 ft. If one assumes that 50% of the deposited material is eroded each year, the final mound would be 13.5 ft high. Given the experience at the disposal site off Coos Bay, Oregon, such an assumption is not unreasonable. In the Coos Bay studies, a disposal mound of dredged materials resulting from disposal of 59,000 yd^3 at a depth of 185 ft was reduced from dimensions of 1900 by 2300 ft to 1000 by 1500 ft (Sollitt et al. 1983). This reduction occurred in 19 months.

During the Ocean Surveys (Pearson et al. 1987), an area of high densities of newly settled YOY Dungeness crab was observed in the SW Navigation Lane. In the Spring of 1985, the highest densities of YOY crab were observed between the 100- and 120-ft depth contours. An area of extremely high densities was observed to the north of the Southwest Site between 100 and 120 ft deep. The stations in this area, which had densities of 400,000 YOY crab/ha during the Spring 1985 Survey, had densities of 5 to 25 crab/ha during the Fall 1985 Survey. Because these high densities occur seasonally rather than continuously, disposal operations can be managed to avoid the high densities of crab.

Because of weather constraints, the bar can be dredged only between May and September; therefore, disposal at the Southwest Site will be within those months. In Year 2 of construction, the bar construction material will be dumped beyond the 120-ft contour over a period of 3.9 months. This operational constraint will allow disposal to be avoided when the YOY are present in the shallower portions of the site, and will aid in preventing an excessive mound by placing the largest single input from the project into the deepest portion of the site. Because maintenance material from the bar can be dredged within 1.3 to 0.8 months, the maintenance schedule can be adjusted to place material into the site in less than 120 ft in the later summer months after the high concentrations of YOY crab are no longer present.

However, minimizing crab losses as a result of entrainment during dredging of the bar should guide the schedule more than considerations of potential disposal impacts.

VERIFICATION OR COMPLIANCE MONITORING

Compliance monitoring is the management activity designed to verify that the dredged materials for disposal are being dumped in the correct location at the correct time. In the Grays Harbor Project, materials from different reaches are destined for different disposal sites. Dredge logs, coupled with periodic dredge inspection by agency personnel, will be used to verify that materials dredged from specific reaches are transported and dumped at the appropriate site.

A variety of navigational systems can be used to monitor the accuracy of the dumping position. In order of expense, the options are as follows:

- Buoy system
- Loran-C
- Miniranger with track plotter and load meter
- Telemetry of position and draft
- Continuous inspection.

Because continuous inspection requires that several shifts of inspectors be aboard the dredges and scows used to transport and dump the materials, this method is not cost-effective. Buoy systems can disrupt navigation and in this project, would require periodic repositioning by a field crew. The Ocean Disposal Review Board (a panel of experts convened by the Seattle District) reviewed the options for navigational control and recommended to the Seattle District that a Miniranger microwave positioning system with a track plotter and load meter be used to verify the dump positions. As discussed above, the dump positions in the Southwest site could be moved periodically in order to spread the material throughout the site and to avoid disposal in the shallower portions of the site in the month of June. The dumping position will be changed by providing new coordinates to the operators of the hopper dredge.

SITE-MONITORING PLAN

BACKGROUND

The general objective of site monitoring is to determine whether changes in disposal operations are needed. The site-monitoring activities are intended to detect whether significant adverse environmental impacts are occurring on resources or resource use beyond the site. Monitoring information is gathered and then considered to determine the need for corrective or remedial action.

Previously, environmental monitoring of ocean disposal and other human activities has usually involved time-series measurements of various physical, chemical, and biological parameters. The goal has usually been to discern whether the data gathered showed any change, and, if so, whether the change could be attributed to the human disturbance at issue. Critiques of such studies (Boesch 1984, Fredette et al. 1986, Segar and Stamman 1986) list the following deficiencies:

- Weak or ineffective designs for sampling and statistical analysis
- Difficulties in relating observed changes to specific causes, particularly difficulties in separating anthropogenic impacts from natural variability
- Difficulties in determining whether the observed changes constitute unacceptable impacts on resources, resource use, or the ecosystem
- Failure to assess the spatial and temporal scale of any potential effects
- Difficulties encountered by regulators in relating study results to existing regulations and to courses of actions.

In response to such deficiencies, many investigators and agencies have called for a tiered approach (Fredette et al. 1986, Segar and Stamman 1986, Zeller and Wastler 1986).

In a tiered approach, simple techniques for monitoring of physical and chemical characteristics occupy the lower tiers while more complex monitoring techniques occupy higher tiers (Zeller and Wastler 1986). Research in basic oceanic processes occupies only the highest tiers. Work at the higher tiers is undertaken only when a need for it is demonstrated by the results of activities at the lower tier. Thus, only the studies needed to address specific management decisions are undertaken. and studies that provide information not germane to the issues are avoided. Monitoring plans will vary in the number of tiers required depending on the potential impacts and other management needs (Zeller and Wastler 1986).

In an ideal tiered approach (Fredette et al. 1986, Segar and Stamman 1986), the following elements would govern the decision-making process:

- General objectives
- Specific monitoring objectives
- For each specific objective, a prespecified level of unacceptable impact
- For each specific objective, a null hypothesis to be tested by monitoring activities
- Decision rules or triggers for deciding whether to move to another tier or to employ corrective or remedial action.

Most authors examining the effectiveness of monitoring programs urge that clear, attainable goals be defined at the outset (Fredette et al. 1986, Segar and Stamman 1986). According to Segar and Stamman (1986), the broad objectives of most monitoring plans are much the same:

- To ensure that there is no threat to human health
- To ensure that no unacceptable harm to the ecosystem or resources occurs
- To make informed management decisions.

The specific objectives vary from plan to plan depending upon the materials for disposal, the site characteristics, and the resources of concern in the general area. Instead of directly monitoring the resource of concern. other parameters that indicate the likelihood of an impact on the resource. and that can be measured more easily or in advance of a more developed impact, are often the more appropriate monitoring parameters (Segar and Stamman 1986).

In the tiered approach, the decision rules indicating the need to go to a higher tier or to employ remedial action are to be defined beforehand (Fredette et al. 1986, Segar and Stamman 1986). Specifying the decision rule alone is not enough. One should also specify potential actions to be taken for the specific outcomes of applying the decision rule to the monitoring results. In establishing tiers and triggers, simply stating a concern for a resource is not sufficient. The quantitative changes in the resource or other variable that indicate unacceptable impact are to be defined a priori as testable null hypotheses (Fredette et al. 1986).

Figure 2 is a schematic diagram of a generalized, tiered monitoring plan for a dredged material disposal site. Tier 1 activities include a bathymetric survey and sediment transport monitoring to determine whether the deposited material is behaving as expected. Such monitoring is placed in the first tier because the effects are not expected to migrate beyond the site unless the

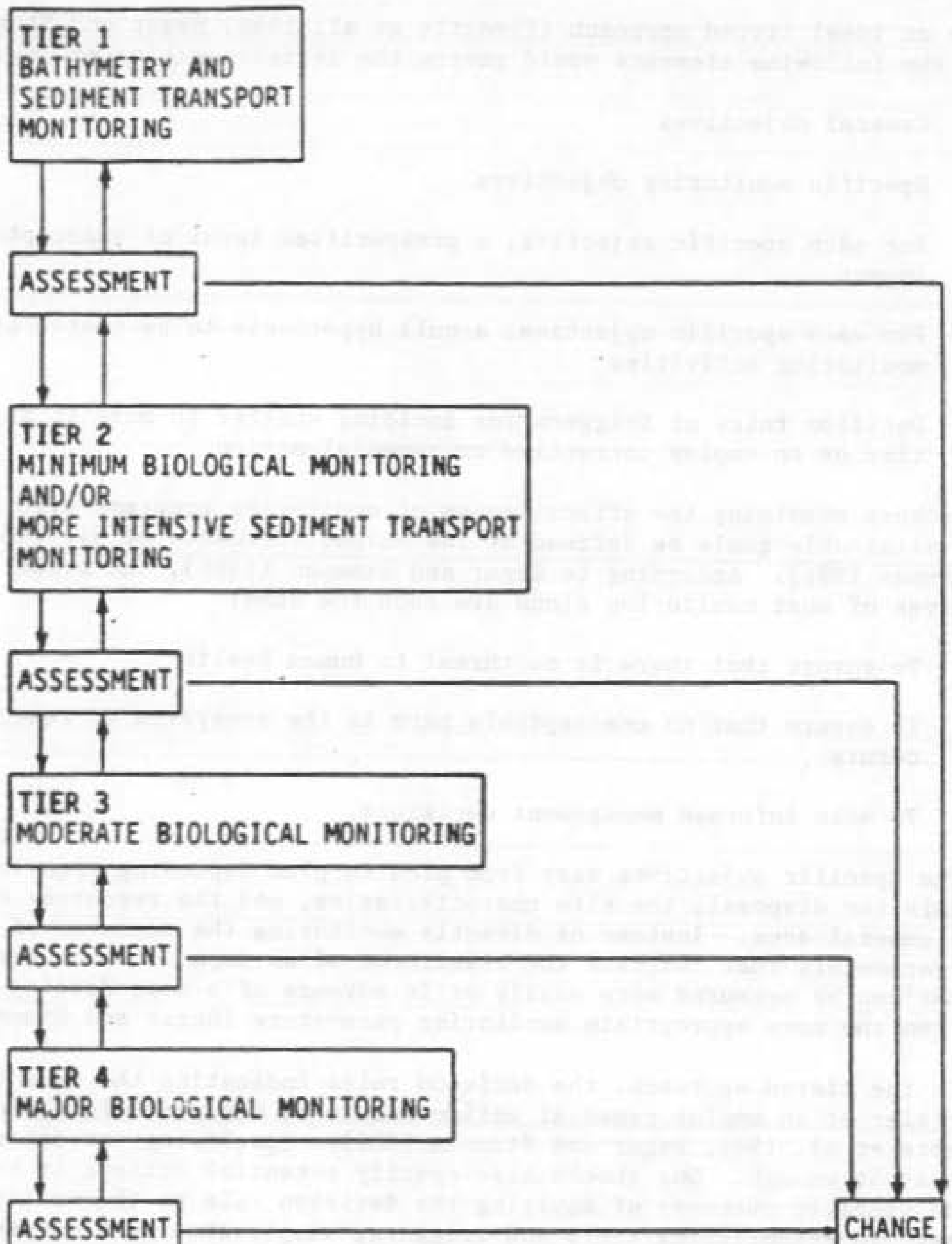

FIGURE 2. A Generalized, Tiered Approach to Monitoring Disposal of Dredged Materials

material does. The Tier 2 activities include more sediment transport monitoring and minimal biological monitoring, with the extent of each component determined by the outcome of the Tier 1 activities. An assessment activity takes place between Tier 1 and 2 to evaluate the results and determine whether there is any need for change, or whether more data will be required before determining a need for change.

Potential options concerning the disposal operations include the following:

- No change needed
- None possible
- Operational changes
  - Scheduling
  - Placement of material within the site
- Change in site location
- No disposal.

If monitoring reveals no cause for concern and, therefore, no need for change, the monitoring and disposal operations would continue as planned. It is possible that the operations could not be changed. For example, the 8-Mile Site is planned for one-time use, thereby eliminating the possibility for subsequent change in disposal operations. Operational changes include adjusting the schedule (time periods or rates) of the disposal to avoid a temporary situation, or placing the material in a different portion of the site than originally planned. In rare cases where the impacts are found to be unavoidable and unacceptable over a large area or long time, a change in site location or the cessation of disposal may be considered.

MONITORING PLANS FOR THE GRAYS HARBOR SITES

The general objectives of the monitoring plans for the 8-Mile and Southwest Sites are first, to verify that no harm occurs to resources, resource use, or the ecosystem beyond the site boundaries and, second, to provide specific information to support informed decisions about managing the sites and the disposal operations. No impacts on human health have been found concerning the migration of pollutants from dredged material [Office of Technology Assessment (OTA) 1987], and the material from Grays Harbor is uncontaminated; therefore, threats to human health are not expected as a result of disposal of dredged materials from Grays Harbor. The specific objectives of monitoring differ for each site and are discussed below in the context of the monitoring tiers. The monitoring techniques are outlined in Appendix A.

Tiered Monitoring at the 8-Mile Site

Table 2 summarizes the tiered monitoring at the 8-Mile Site. Only two tiers are proposed and both tiers focus on determining whether the deposited materials behave as expected. Because the use of the 8-Mile Site is a one-time occurrence limited to construction there are no options for changing the disposal operation. Monitoring is undertaken to determine the accuracy of the predictions concerning mounding and sediment transport.

No resource impacts are anticipated from disposal at the 8-Mile Site. The silty material that was dredged by clam shell and dumped at the site is expected to form a mound 10-15 ft high that will persist for some time. Movement, if any, is expected to be to the NW or NNW over more of the same relict deposit that underlies the site.

TABLE 2. The Tiered Monitoring Plan for the 8-Mile Site.

MATERIAL: Sandy silts for the upper reaches.

PREDICTIONS: Clamshell-dredged silts will form a persistent cloddy mound under the dump position.
Sediment transport will be minimal and to the NW or NNW.

SPECIFIC OBJECTIVES: To determine whether the dredged material is behaving as expected.

What is the size and shape of the mound?

Is there evidence of sediment transport?

TIER 1

ACTIVITIES: Bathymetric survey for size and shape of the mound.

Side-scan sonar survey with bottom-grab sampling for sediment transport.

ASSESSMENT QUESTIONS: Is the material behaving as expected?
Is there evidence of sediment transport, especially, toward the sandy fingers around the site?

TRIGGER FOR MOVING TO TIER 2: Silt is moving toward the sandy fingers.
HYPOTHESIS: At gravelly stations between the mound and the sandy fingers, silt and clay content is increased from a mean of 3.0% to over 23.5%.

CHANGE OPTIONS: None needed.
None possible.

TIER 2

ACTIVITIES: More sediment sampling with bottom grabs.

ASSESSMENT QUESTION: Is the material moving into the sandy fingers?

DECISION RULE: HYPOTHESIS: At sandy stations on the fingers, TOC increases from a background mean of 0.26% to a mean of 2.0%.

CHANGE
OPTIONS: None needed.
None possible.

The specific objectives of monitoring at the 8-Mile Site are to determine whether the material is behaving as predicted, and, if not, to determine whether it is moving toward the sandy fingers (i.e., not in the predicted NW direction). This site was selected for the silty material to keep the material away from crab fishing areas because silts with high sulfide content have been observed to impair bait odor response in the laboratory and could impair the efficiency of baited traps (Pearson and Woodruff 1987).

Tier 1 activities include a bathymetric survey and a side-scan sonar survey with bottom-grab sampling. The results of pre- and postdisposal bathymetric surveys will be used to evaluate general changes in the size and shape of the mound. Changes in the volume of the mound will not be determined because the volume of the mound can change as a result of consolidation and migration of the silty material into the spaces of the coarser sediment of the relict gravel deposit, rather than transport.

A subbottom profiler should be able to distinguish between the deposited silty material and the underlying gravel and will be used to provide cross sections of the disposal mound. Data from the subbottom profiler may or may not be adequate for estimating changes in volume.

The side-scan sonar survey and sediment sampling will be used to seek evidence of transport other than that derivable from changes in mound volume. The side-scan sonar will be used to determine the edges of the mound and may indicate whether material is moving away from the mound. Sediment sampling with analysis for grain size distribution will be used to detect evidence of silty material migrating from the site.

Elevated content of silt and clay in gravelly sediment will be used to trace the movement of silty dredged materials. In studies of the Coos Bay disposal site, analyses of grain size and organic content distinguished silty dredged material from the sandy native sediments (Sollitt et al. 1983). The relict gravel deposit in and around the 8-Mile Site has an average silt and clay content of 3.0% while the silty materials from the upper reaches of Grays Harbor have silt and clay contents between 40% and 75% (U.S. Army Corps of Engineers 1982). Consequently, the difference between the materials is sufficiently large for this approach to be feasible.

The trigger for considering moving from Tier 1 to Tier 2 is finding a silt and clay content over 23.5% at gravelly stations between the mound and the sandy fingers. This trigger value represents a 50% dilution of native gravel with 3% silt and clay by dredged materials with 50% silt and clay. Statistical analysis of the sediment data from the Ocean Surveys (Pearson et al. 1987) indicates that 10 samples per area (i.e., 10 samples on the mound and 10 samples between the mound and the fingers) should detect such a difference in silt and clay content at the 90% confidence level.

Tier 2 activities at the 8-Mile Site consist of more sediment sampling to determine whether the material has moved into the sandy fingers around the site. The evidence for dredged materials in the sediments of the sandy fingers will be finding increases in Total Organic Carbon (TOC) from the mean of 0.26% for the native sediments to a mean of 2.0%. Analysis of the data from the Ocean Surveys (Pearson et al. 1987) indicates that 16 samples per area should detect such differences at the 90% confidence level.

Tiered Monitoring at the Southwest Site

Table 3 summarizes the tiered monitoring at the Southwest Site. Two tiers are proposed. The first tier focuses on determining the behavior of the disposal mound with minimal biological monitoring of crab distribution and the second tier entails more intensive study of crab distribution.

Because the site location and timing of disposal operations are designed to avoid the high densities of YOY crab north of the site, no significant resource impacts from disposal at the Southwest Site are anticipated. A low profile, wide mound is predicted to result from the disposal of sandy material, and the area of the mound will increase as the dumping position is rotated through the site. The volume of the mound is expected to decrease by 50% per year as a result of consolidation processes and transport from winter storms. The maximum height of the mound above the predisposal base is predicted to be no more than 14 ft. The area of high crab density is expected to remain in its observed location north of the site, and the portion of the site beyond the 120-ft contour is expected to continue to have lower crab densities than the rest of the general area.

TABLE 3. The Tiered Monitoring Plan for the Southwest Site.

MATERIAL: Clean sand from the bar.

PREDICTIONS: Sand dredged by hopper will form low profile mound of growing size.

Rotation of dump position will prevent excessive height.

50% of sand will erode per year during winter storms.

Area of high YOY crab density will remain in expected location north of the site.

Area beyond 120-ft contour will have expected low density of crab.

SPECIFIC OBJECTIVES: To determine whether the dredged material is behaving as predicted.

What is the size and shape of the mound? Is there any excessive height to mound?

To verify expected crab distribution.

Does the area north of the site contain orders of magnitude more crab than the site? Does the site beyond 120 ft have lower crab densities than the shallower areas?

<u>TIER 1</u>

ACTIVITIES: Bathymetric survey for size and shape of the mound. TV

tows with trawling for crab distribution.

ASSESSMENT QUESTIONS: Is the material behaving as expected?

What is size and shape of the mound?
Is there excessive height?
Is erosion occurring at the expected rate?

Is the crab distribution as expected?

TABLE 3. (Cont)

TRIGGER FOR MOVING TO TIER 2:	The area of high crab density is moving into the site. HYPOTHESIS: Crab density in June within the site is 100 times higher than in the area to the north.
TRIGGER FOR CHANGING DISPOSAL OPERATIONS:	The mound is too high. HYPOTHESIS: The mound in less than 120 ft is building more than 20 ft over more than 50% of its area.

CHANGE OPTIONS:	None needed.
	None possible.
	Operational changes.
	    Scheduling.
	    Placement of material within the site.
	Change in site location.
	No disposal.

TIER 2

ACTIVITIES:	Trawl survey with supplemental TV tows for areal distribution of crab.
ASSESSMENT QUESTION:	Is the crab distribution such that a change needs consideration?
TRIGGER FOR CHANGING DISPOSAL OPERATIONS:	The area of high crab density has moved into the site. HYPOTHESIS: Crab density within the site is 200 times greater than in the general area.

CHANGE OPTIONS:	None needed.
	None possible.
	Operational changes.
	    Scheduling.
	    Placement of material within the site.
	Change in site location.
	No disposal.

The specific objectives of monitoring at the Southwest Site are to determine that the mound is not building to excessive height, and to verify that the patterns of crab density are remaining as expected.

Tier 1 activities include a bathymetric survey and minimal biological monitoring with TV tows and beam trawls. Changes in the size and shape of the mound will be evaluated by comparing contour charts from successive surveys. Changes in volume will not be determined. Although, the precision of the bathymetric surveys is sufficiently great enough to support accurate estimates of volume changes, calculation of changes in volume assume that the baseline (i.e., the contours of the native bottom) is stable over successive surveys (Morton 1983). Such an assumption is not reasonable for most of the Southwest Site where sediment transport is known to occur naturally during storms.

The characteristics of the bar sand to be dumped are too close to those of the native sands for side-scan sonar, subbottom profilers. and sediment analyses to reliably distinguish the two. Consequently, these monitoring techniques are not proposed for the Southwest Site.

Tier 1 activities also include TV tows and trawls to verify the patterns of crab distribution. TV tows proved effective during the Ocean Surveys (Pearson et al. 1987) in providing a rapid assessment of the patterns in crab distribution, and in precisely locating abrupt changes in crab density. . Trawls complement the TV tows by providing a quantitative measure of density.

The trigger for moving from Tier 1 to Tier 2 will be finding that the mean crab density in June between the 90- and 120-ft contours within the site is greater than 100 times that within the area to the north, between the same depth contours. Such a finding would suggest, but not demonstrate, that the area of high crab density may have shifted into the site. Statistical analysis of replicate trawls made during the Ocean Surveys (Pearson et al. 1987) indicates that four replicate trawls per area would be sufficient to detect where crab density differs by a factor of 10.

The trigger for considering a change in disposal operations is finding during the spring bathymetric surveys that the height of the disposal mound exceeds the expected maximum of 20 ft over more than 50% of its area.

Tier 2 activities would be a trawl survey of the site and the general area to determine whether the shift in crab distribution was such that changes in disposal operations need consideration. The results of the trawl survey would be evaluated to determine whether the site contained such high densities of YOY crab compared to other areas in the general region that the densities suggest a unique value to their observed location. The trigger for such consideration would be finding that the portion of the site between 90 and 120 ft showed a mean crab density in June that was 200 times the mean of the general area. During the 1985 Spring Survey, such a difference was observed between the area of high density north of the site and the shallower portions of the Southwest Site. Such a finding would indicate that the high density area had shifted into the site. Assessing the significance of the potential impact to the resource would be necessary in considering any changes in disposal operations.

Possible Outcomes and Potential Remedial Action at the Southwest Site

At the Southwest Site, the mound may not lose 50% of its volume per year. The outcome to be avoided is the building of a mound so high that concern for navigation arise as has happened with the disposal site off Newport, Oregon (Reese and Turner 1986). Dispersing the dumping positions was included as part of the planned operations to prevent such an occurrence. However, if the mound builds to a greater height than acceptable, the dumping positions may have to be redistributed. The spacing between the dumping positions may have to be increased, or disposal operations may have to be shifted to deeper portions of the site.

In the Southwest Site, the area for large concentrations of newly settled YOY crab might move into the site. If the TV tows and limited trawl operations of Tier 1 suggest such an occurrence, then the trawl survey of Tier 2 is triggered. The biological monitoring activities in Tier 2 are intended to provide greater perspective on any large concentrations of crab seen within the disposal site. In particular, the trawl survey will aim to determine whether any observed concentrations are unique to the location or simply reflect an unusually high settlement that year. The Tier 1 monitoring could reveal that the aggregation area is stable. If so, restrictions on thetiming of disposal in depths shallower than 120 ft may be reconsidered and, after assessment, relaxed.

MONITORING SCHEDULE

Table 4 provides the schedule for monitoring the two sites. The schedule includes predisposal bathymetric surveys for both sites. For each site, the first postdisposal survey will be in late summer or early fall, after completion of the summer's disposal operations and before the fall gales begin in the middle of October. Comparison of bathymetry between the predisposal and postdisposal surveys will show how the mound built during seasonal disposal. Spring bathymetric surveys will determine how the mounds changed as a result of the winter storms. In subsequent years, the bathymetric surveys occur only once annually for the 8-Mile Site and twice annually for the Southwest Site (before and after disposal of the maintenance materials at the Southwest Site).

Tier 1 monitoring of YOY crab distribution around the Southwest Site needs to be done in June because of the seasonal abundance of that life stage in the area.

An assessment report synthesizing the findings of the monitoring program will be submitted after 2 years of annual postconstruction monitoring. This report will synthesize the findings of the monitoring program and make recommendations concerning the need for further monitoring and modifications to the disposal operations.

TABLE 4. Schedule for Tier 1 Monitoring Activities at Two Ocean Disposal Sites off Grays Harbor (Assuming Construction Starts in 1990)

ACTIVITY	DATE	SCOPE
8-Mile Site		
Predisposal	APR 90	Bathymetric and Side-Scan Sonar
Postdisposal	AUG 90	Bathymetric only
Predisposal	APR 91	Bathymetric only
Postdisposal	AUG 91	Bathymetric and Side-Scan Sonar
1st Annual	AUG 92	Bathymetric and Side-Scan Sonar
2nd Annual	AUG 93	Bathymetric only
Report	JUN 94	
Southwest Site		
Predisposal	JUN 90	Bathymetric plus TV Tows and Trawls
Postdisposal	OCT 90	Bathymetric only
1st Annual	MAY 91	Bathymetric only for predisposal of maintenance material
	JUN 91	TV Tows and Trawls
	AUG 91	Bathymetric only for postdisposal of maintenance material
2nd Annual	MAY 92	Bathymetric only for predisposal of maintenance material
	JUN 92	TV Tows and Trawls
	AUG 92	Bathymetric only for postdisposal of maintenance material
Report	JUN 93	

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APPENDIX A

MONITORING TECHNIQUES

MONITORING TECHNIQUES

8-MILE SITE

FIRST TIER: BATHYMETRIC SURVEY FOR SIZE AND SHAPE OF THE MOUND

Products:

A time-series of bathymetric maps indicating the shape and size of the disposal mound

A series of cross sections of the mound

Records from the subbottom profiler

Approach:

A survey vessel runs tracklines over the area in and around the disposal mound.

Depth data are collected by a recording precision echosounding fathometer. The fathometer should receive a bar check calibration or its equivalent.

Position given by Miniranger or Global Positioning System (GPS). All the surveys will require greater precision than that given by Loran-C. Either a Miniranger or Global Positioning System with shore station should be used. First step of any fieldwork is setup of shore transponder; last step is its breakdown. With a shore station GPS will provide a precision of ± 1 meter; a Miniranger, a precision of perhaps ± 2 meters.

Depth data are adjusted to NOS tidal datum of Mean Lower Low Water and then contoured to produce a bathymetric map.

Changes in the size and shape of the mound are evaluated through comparison of the bathymetric contour maps. A predisposal survey is necessary to provide the baseline. Two annual followup surveys are planned.

Cross sections of the mounds will be developed from the postdisposal surveys using the predisposal survey as baseline. This approach assumes that the baseline is stable or any changes are small compared to those associated with the disposal mound. Available evidence indicates that such an assumption is reasonable for the 8-Mile Site.

The subbottom profiler should be able to distinguish the silty dredged materials from the underlying native gravelly sand. If so, cross sections may also be developed from the profiler data.

Effort:

The area to be surveyed is the circular site (0.5 stat mi^2) and its periphery to a total of 1.0 mi^2.

Survey boat runs tracklines with echosounding fathometer along a total of 21.4 n mi:

200 ft spacing between tracklines

10 ft interval between soundings

26 tracklines of 5000 ft will cover a rectangular area of 1 mi^2.

Total length of the tracklines is 21.4 n mi.

The spacing between tracklines and soundings is equivalent to current COE practice in surveying the Point Chehalis Site.

Equipment:

Positioning system
Recording fathometer

Vessel Support:

The COE vessel MAMALA is capable of supporting this operation.

Time Budget for Fieldwork for One Survey:

Total of 4 days for field party and vessel.

Assuming the positioning system is already established, surveying 21.4 n mi at 2 knots will take 3 days. A weather contingency of 1 day should be allowed.

FIRST TIER: SIDE-SCAN SONAR WITH GROUND TRUTHING FOR SEDIMENT TRANSPORT

Products:

A series of maps showing the distribution of bottom types in and around the site and the extent of the disposal mound of silty material

Tabular data on the ground truthing of the side-scan sonar records including positions of bottom samples and results of laboratory analyses of grain size distribution and TOC

The records of side-scan sonar tracklines

The records of the subbottom profiler

An evaluation of the decision rule.

Approach:

The survey vessel runs tracklines towing a recording side-scan sonar. Tracklines extend through the site to the sand fingers on NE, E and S and over the gravel deposit to the NW (The expected direction of transport). A sonar of 500 kHz should show the presence of fine grain sediment over the underlying gravel. It will probably not show silt mixed into sand. The subbottom profiler may be towed with the side-scan sonar if there is no acoustical crosstalk.

Ground truthing is accomplished by sampling the bottom with a Nakai sampler at intervals and when the sonar trace shows a change in the bottom. The sample is examined visually and recorded as gravel, sand, silty sand or silt. Samples are saved for laboratory analysis of grain size distribution of major fractions (% gravel, sand, silt, and clay) and TOC. Only a subset may need analysis.

To provide data for evaluating the decision rule, an array of 10 stations between the mound and the sandy fingers as well as 10 stations on the mound will be occupied for sediment grabs. The sediment samples will be analyzed for grain size distribution and the results evaluated against the decision rule.

Equipment:

Positioning system
Recording fathometer
Side-scan sonar system
Subbottom profiler
Nakai bottom sampler

Effort:

Tracklines should be 3000 ft (1/2 n mi) apart. Total length of tracklines will be 4 lines X 2 n mi/line = 8 n mi.

Sample with Nakai sampler at 1500-ft (0.25 n mi) intervals plus when bottom type changes. (8 n mi/0.25 n mi/sample) + 4 samples = 36 Nakai samples

Time Budget for Fieldwork for One Survey:

Total for field party and vessel is 3 days.

Surveying the 8 n mi at 2 knots and conducting the sediment sampling will take 2 days. A weather contingency of 1 day should be allowed.

If the subbottom profiler needs to be towed separately from the side-scan sonar, then another 1 to 1.5 days will be needed. Acoustical crosstalk between the two devices is not expected, but its absence needs field confirmation.

SECOND TIER: MORE SAMPLING WITH NAKAI FOR GRAIN SIZE AND TOC

Products:

Verification of whether or not silty materials are moving into the sandy fingers around the site

A map of distribution of % silt and clay

Tabular data on sampling positions, grain size distribution and TOC An evaluation of the decision rule.

Approach:

Survey vessel focuses sampling between disposal mound and sandy fingers and on the sandy fingers. Sampling effort needs to be established in light of results from first tier.

Sediment samples from the sandy fingers are analyzed for TOC, and the results evaluated against the decision rule.

Equipment:

Positioning system
Recording fathometer
Nakai sampler
A small box core or van Veen grab may be needed instead of Nakai.

Effort:

Effort cannot be fully established now. Plan for 3 days of scientific operations and at least 40 samples for grain size distribution and TOC.

Vessel support:

The MAMALA or a fishing boat out of Westport can support the work.

Time Budget for Fieldwork for One Survey:

Total of 4 days is estimated.
Scientific operations are planned to take 3 days. A weather contingency of 1 day is planned.

THE SOUTHWEST SITE

FIRST TIER: BATHYMETRIC SURVEY FOR SIZE AND SHAPE OF THE MOUND

Products:

A time-series of bathymetric maps indicating the shape and size of the disposal mound

A series of cross sections of the mound

Approach:

A survey vessel runs tracklines over the area in and around the disposal mound. Only the past year's disposal mound is surveyed, not the entire site.

Depth data are collected by recording precision echosounding fathometer. The fathometer should receive a bar check calibration or its equivalent.

Position given by Miniranger or Global Positioning System (GPS). All the surveys will require greater precision than that given by Loran-C. Either a Miniranger or Global Positioning System with shore station should be used. First step of any fieldwork is setup of shore transponder; last step is its breakdown. With a shore station GPS will provide a precision of ± 1 meter; a Miniranger, a precision of perhaps ± 2 meters.

Depth data are adjusted to NOS tidal datum of Mean Lower Low Water and then contoured to produce the bathymetric map.

Changes in the size and shape of the mound are evaluated through comparison of the bathymetric contour maps. A predisposal survey is necessary to provide the baseline. Two annual followup surveys are planned.

Cross sections of the mounds will be developed from the postdisposal surveys using the predisposal survey as baseline. This approach assumes that the baseline is stable. Available evidence suggests that this assumption may not be valid for the Southwest Site. However, because sediment transport occurs primarily during winter storms, performing a predisposal survey in the spring and a postdisposal survey in the late summer should be allow the baseline to be derived from a native bottom that may have changed little over the summer.

Because of the similarity between the dredged materials and the native sand, a subbottom profiler and side-side sonar are unlikely to distinguish the two materials and will not be used at the Southwest Site.

Effort:

The area to be surveyed is the disposal mound (0.5 stat miz) and its periphery to a total of 1.0 mi^2.

Survey boat runs tracklines with echosounding fathometer along a total of 21.4 n mi:

200 ft spacing between tracklines

10 ft interval between soundings

26 tracklines of 5000 ft will cover a rectangular area of 1 mi^2.

Total length of the tracklines is 21.4 n mi.

The spacing between tracklines and soundings is equivalent to current COE practice in surveying the Point Chehalis Site.

Equipment:

Positioning system
Recording fathometer

Vessel Support:

The COE vessel MAMALA is capable of supporting this operation. Equipping the vessel with a track plotting device such as the "helmsman's aid" used in other COE projects (Morton 1983) would enhance the repeatability of the tracklines.

Time Budget for Fieldwork for One Survey:

Total time for the field party and vessel is 4 days.

Surveying the 21.4 n mi of tracklines at 2 knots would take 3 days. A weather contingency of 1 day should be allowed.

FIRST TIER: TV TOWS WITH GROUND TRUTHING FOR CRAB DISTRIBUTION

Products:

Verification that the location of area of high crab density and line of seaward extent to crab density are remaining the same as previously observed

Maps of crab distribution

An evaluation of the decision rule concerning crab distribution.

Approach:

A survey vessel tows a TV system along 4 tracklines of 3 n mi each through the SW Site. Tows from Ocean Survey Stations 113. 116, 117. 135, and 136 will be repeated. If conditions preclude long straight tows, more short ones will be conducted to same overall level of effort. The record of the precision depth recorder will be marked every 400 ft along the trackline and the vessel's position logged. The fathometer trace will also be marked and a position logged at time of noteworthy observation. Crab sightings will be logged. Qualitative abundance estimates from the recorded video image will be made to provide data for contouring of crab distribution. Locations of high crab density and abrupt changes in crab density will be recorded.

For ground truthing, trawls with 3-m plumb staff beam trawl will be conducted as on the ocean surveys. Four trawls will be set along the depth contours within the previously observed area of high crab density and four trawls set within the site between 100 and 120 ft. Four additional trawls will be set at discretion of chief scientist in light of TV tow results. The trawls will be sorted for crab plus major macroepifaunal taxa, but no detailed catch processing will be done.

Effort:

4 tracklines of 3 n mi equals a total of 12 n mi. Over about 2 days 7 TV tows of 4.9 n mi were accomplished in the SW lane during the Fall 1985 Ocean Survey.

12 trawls at 3 or 4 per day.

1 hydrographic cast per day

Equipment:

Positioning system

TV system:

ROV Dart or SCCWRP system

3-m plumb staff beam trawl plus backup

Sorting table

Generator:

If vessel lacks clean power at 120 ac, a generator will be needed.

Regulated power supply system is a must.

Hydrographic probe with minicomputer.

Vessel Support:

The MAMALA cannot conduct trawling although it can support the TV tows. A fishing vessel from Westport will be chartered to conduct the trawls.

Time Budget for Fieldwork for One Survey:

Total time for field party and vessels will be 12 days.

The TV tows and trawls will require 9 days. A weather contingency of 3 days should be allowed. The TV tows and the trawls will be performed during the same work period. A scientist on the MAMALA will coordinate the trawling by the fishing boat with the TV tows by the MAMALA.

TIER 2: TRAWL SURVEY WITH SUPPLEMENTAL TV TOWS FOR AREAL DISTRIBUTION OF CRAB

Products:

A determination of the areal distribution of crab in the SW Navigation Lane

Maps and tabular data of crab density

An evaluation of the decision rule.

Approach:

The survey plan would be based on the results of Tier 1 sampling, but one can envision a series of trawls along transect lines as in the 1985 Ocean Surveys. For 3 transect lines, trawls would be along the contours at 95, 105, 115, 120 and 130, and 135 ft. Duplicate trawls at Ocean Survey Stations 3 and 7 would be repeated. Catch processing would be for crab and major macroepifaunal taxa with no detailed processing.

TV tows would be positioned based on results of Tier 1 and used to identify the locations of abrupt change in crab density. Procedures will be as for Tier 1 TV tows.

Hydrographic casts would be taken at the beginning and end of each transect line plus daily.

Effort:

3 transects of 6 trawls each = 18 trawls Duplicate trawls at Stations 3 and 7 = 4 trawls Discretionary trawls = 2 trawls

Total number of trawls is 24.

Equipment:

Positioning system
TV system:
ROV Dart or SCCWRP system
3-m plumb staff beam trawl plus backup
Sorting table

Generator:

If the vessel lacks clean power at 120 ac, a generator will be needed.

Regulated power supply system is a must.

Hydrographic probe with minicomputer.

Vessel Support:

The MAMALA cannot conduct trawling although it can support the TV tows. A fishing vessel from Westport will be chartered to conduct the trawls. Because the TV tows are secondary in this effort, the fishing vessel may be able to conduct all the activities.

Time Budget for Fieldwork for One Survey:

Total time for the field party and vessel is 12 days.

The trawls with supplemental TV tows will require 9 days. A weather contingency of 3 days should be allowed.